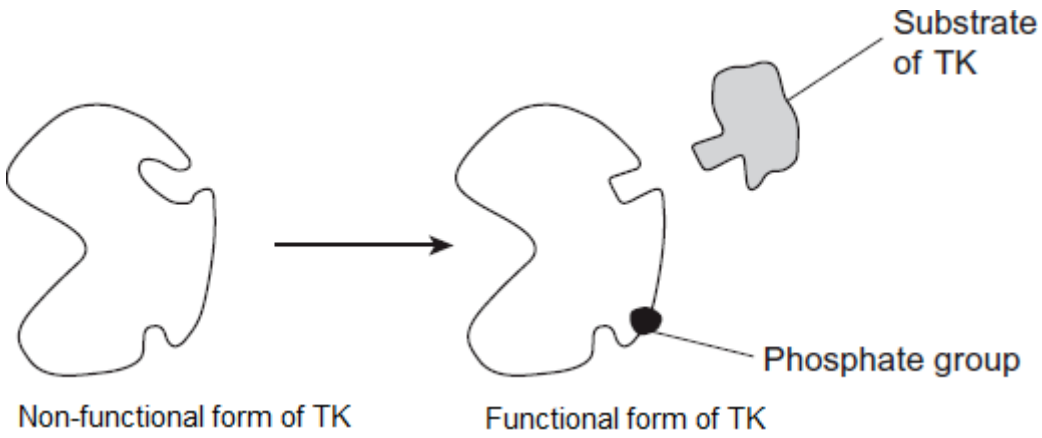
AQA Extra Questions on 1.4 (answers at the back)

Q1. The enzyme tyrosine kinase (TK) is found in human cells. TK can exist in a non-functional and a functional form. The functional form of TK is only produced when a phosphate group is added to TK.

This is shown in **Figure 1.**

Figure 1



(a) Addition of a phosphate group to the non-functional form of TK leads to production of the functional form of TK.

Explain how.

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(2)

(b) The binding of the functional form of TK to its substrate leads to cell division. Chronic myeloid leukaemia is a cancer caused by a faulty form of TK. Cancer involves uncontrolled cell division.

Figure 2 shows the faulty form of TK.

Figure 2

Faulty form of TK

Suggest how faulty TK leads to chronic myeloid leukaemia.

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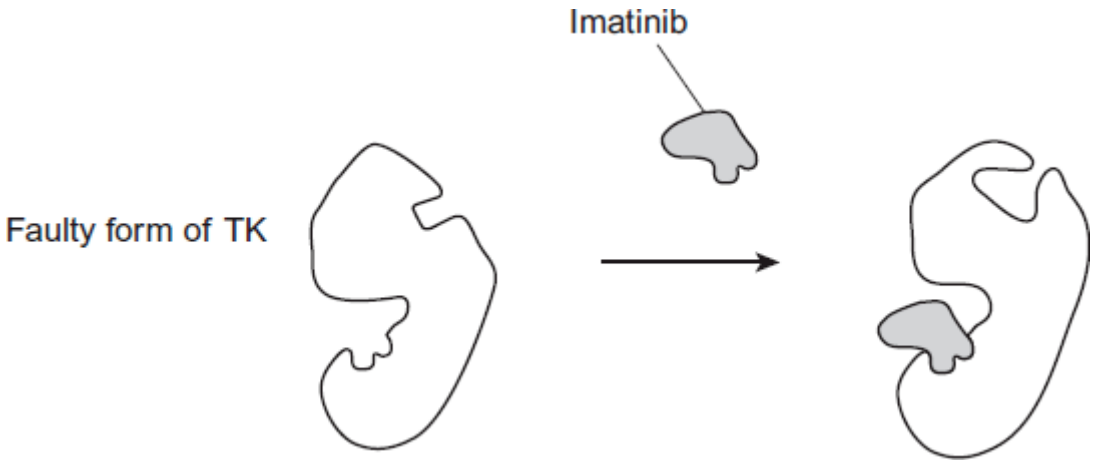
(2)

(c) Imatinib is a drug used to treat chronic myeloid leukaemia. **Figure 3** shows how imatinib inhibits faulty TK.

Figure 3



Using all of the information, describe how imatinib stops the development of chronic myeloid leukaemia.

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(2)
(Total 6 marks)

Q2. Read the following passage.

Aspirin is a very useful drug. One of its uses is to reduce fever and inflammation. Aspirin does this by preventing cells from producing substances called prostaglandins. Prostaglandins are produced by an enzyme-controlled pathway. Aspirin works by inhibiting one of the enzymes in this pathway. Aspirin attaches permanently to a chemical group on one of the monomers that make up the active site of this enzyme.

The enzyme that is involved in the pathway leading to the production of prostaglandins is also involved in the pathway leading to the production of thromboxane. This is a substance that promotes blood clotting. A small daily dose of aspirin may reduce the risk of myocardial infarction (heart attack).

Use information from the passage and your own knowledge to answer the following questions.

(a) Name the monomers that make up the active site of the enzyme (lines 6 – 7).

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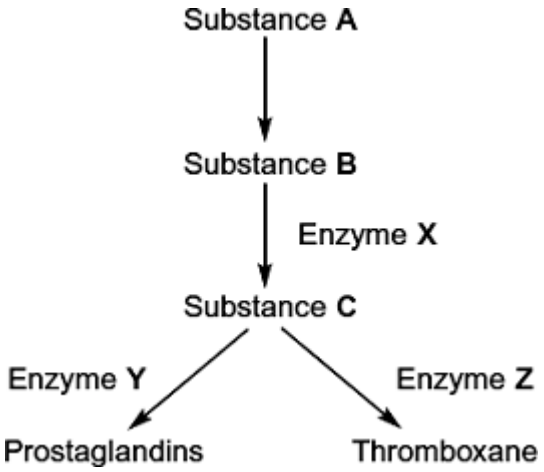
(1)

(b) The diagram shows the pathways by which prostaglandins and thromboxane are formed.



(i) Aspirin only affects one of the enzymes in this pathway. Use information in lines
5 – 7 to explain why aspirin does **not** affect the other enzymes.

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(2)

(ii) Which enzyme, **X**, **Y** or **Z**, is inhibited by aspirin? Explain the evidence from the passage that supports your answer.

Enzyme .....

Explanation .....

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(2)

(c) Aspirin is an enzyme inhibitor. Explain how aspirin prevents substrate molecules being converted to product molecules.

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(2)

(d) Aspirin may reduce the risk of myocardial infarction (lines 8 – 12). Explain how.

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(*Extra space*) .....

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(3)
(Total 10 marks)

Q3. The equation shows the breakdown of lactose by the enzyme lactase.

(a) (i) Name the type of reaction catalysed by the enzyme lactase.

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(1)

(ii) Name monosaccharide **X**.

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(1)

(b) (i) Describe how you would use a biochemical test to show that a reducing sugar is present.

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(2)

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(ii) Lactose, galactose and monosaccharide **X** are all reducing sugars.
After the lactose has been broken down there is a higher concentration of reducing sugar. Explain why.

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(1)

(c) A high concentration of galactose slows down the breakdown of lactose by lactase.
Use your knowledge of competitive inhibition to suggest why.

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(2)

(d) People who are lactose intolerant are **not** able to produce the enzyme lactase.
Explain why these people get diarrhoea when they drink milk containing lactose.

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(2)
(Total 9 marks)

Q4. Gangliosides are lipids found in the cell surface membranes of nerve cells. Hexosaminidase is an enzyme present in blood that breaks down gangliosides. If gangliosides are not broken down, they damage nerve cells.

(a) Hexosaminidase only breaks down gangliosides. It does not break down other lipids.

Explain why this enzyme only breaks down gangliosides.

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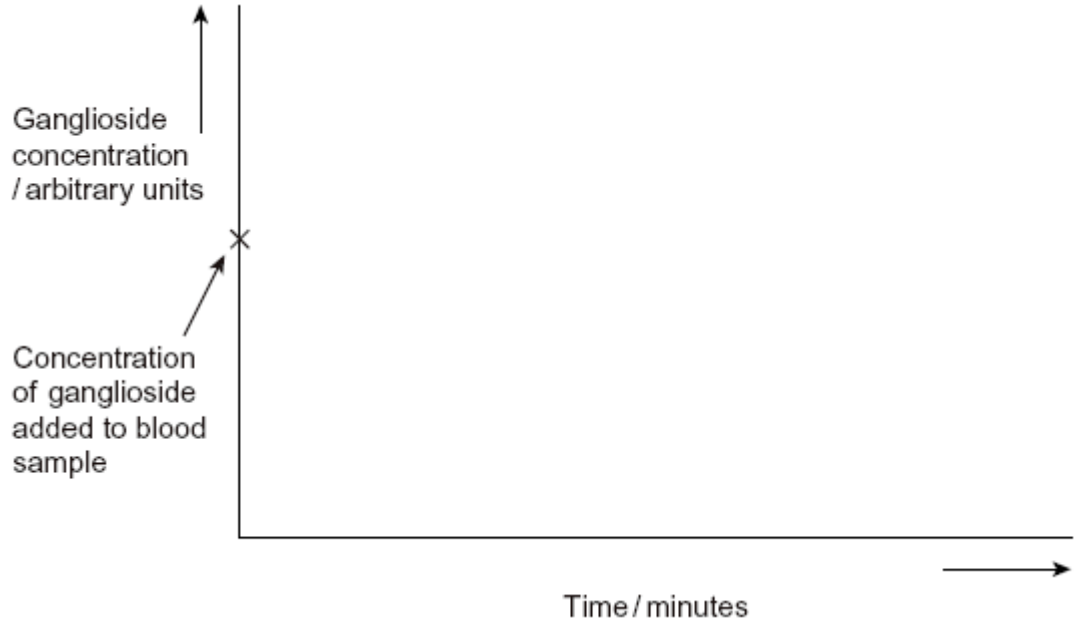
(3)

(b) Hexosaminidase is found in the blood of healthy people. People with Tay Sachs disease do not have this enzyme in their blood.

Doctors confirm Tay Sachs disease by using a blood test. The technician carrying out the test adds a solution containing a high concentration of gangliosides to a sample of blood from the person being tested. The technician then measures the concentration of gangliosides in the person's blood at regular intervals.

(i) Complete the graph below by sketching a curve to show the results you would expect for a person with Tay Sachs disease. Label this curve **T**.



(1)

(ii) Sketch a curve on the same graph to show the results you would expect for a healthy person who does **not** have Tay Sachs disease. Label this curve **H**.

(1)

(c) Scientists are trying to find a way to give the missing enzyme to people with Tay Sachs disease. Suggest why they cannot give the enzyme as a tablet that is swallowed.

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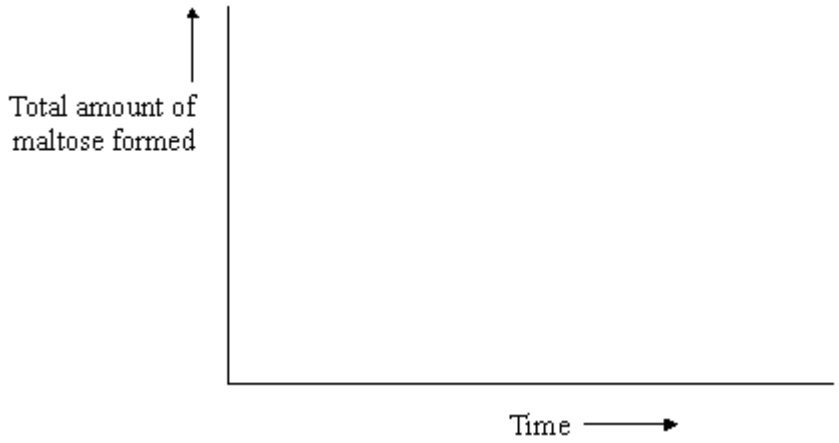
(2)
(Total 7 marks)

Q5. (a) Amylase is an enzyme which hydrolyses starch to maltose. Some amylase and starch were mixed and the mixture incubated at 37 °C until the reaction was complete.

(i) Sketch a curve on the axes below to show the progress of this reaction.



(1)

(ii) Explain why the rate of the reaction decreases as the reaction progresses.

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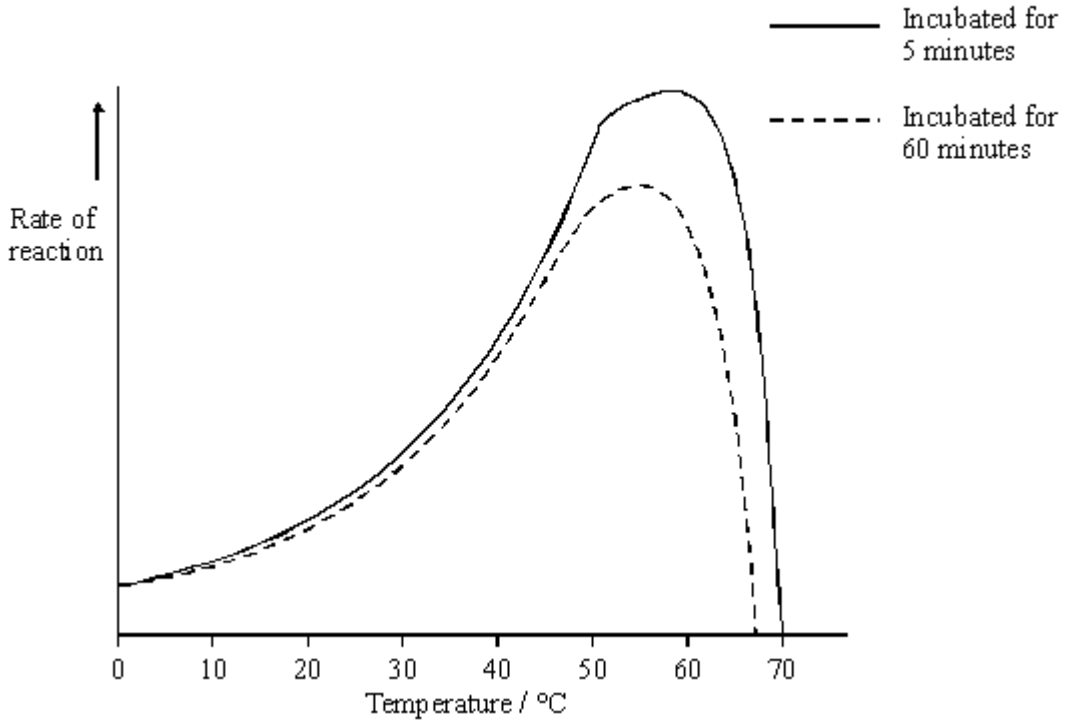
(2)

The effect of temperature on the rate of reaction of an enzyme was investigated. A test tube containing the enzyme and a test tube containing the substrate were incubated separately at each of the temperatures being investigated. After 5 minutes, they were mixed and the rate of reaction was determined. The experiment was repeated but, this time, the enzyme and the substrate were left for 60 minutes before they were mixed. The results of the investigation are shown in the graph.



(b) The enzyme solution used in this investigation was made by dissolving a known mass of enzyme in a buffer solution. Explain why a buffer solution was used.

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(1)

(c) (i) Use the graph to describe how incubation time affects the rate of the reaction.

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(2)

(ii) The maximum rate of reaction with an incubation time of 60 minutes is less than the maximum rate of reaction with an incubation time of 5 minutes. Explain why.

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(3)

(d) Explain how inhibitors affect the rate of enzyme-controlled reactions.

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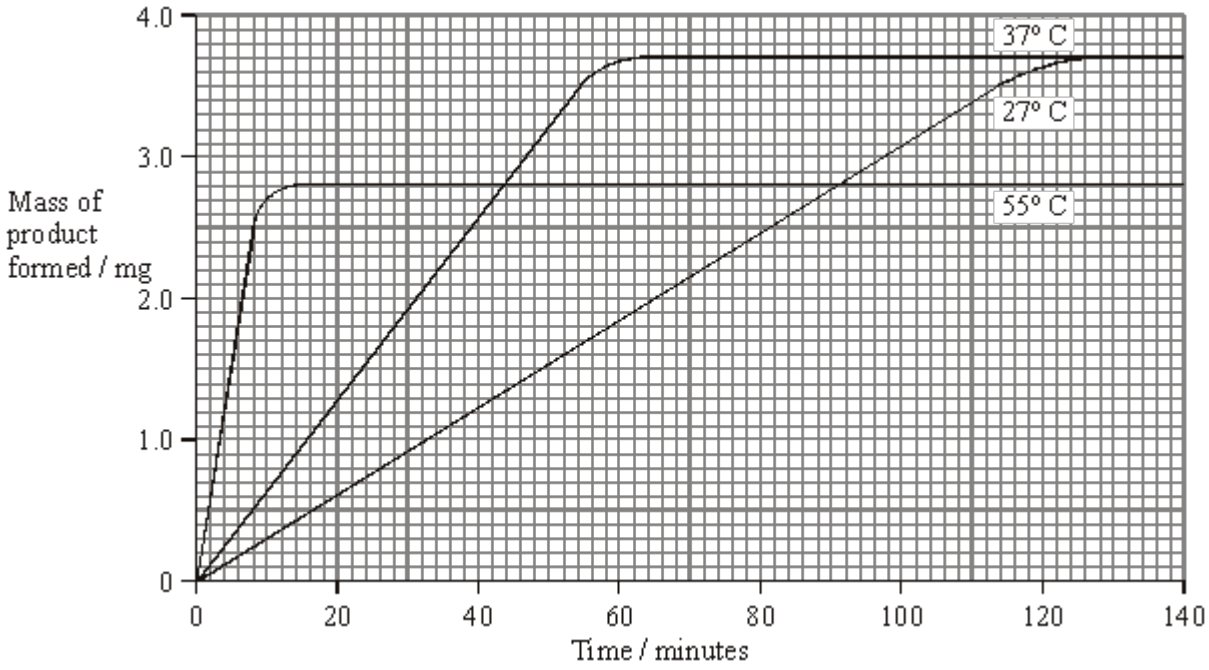
(6)
(Total 15 marks)

Q6. A student carried out an investigation into the mass of product formed in an enzyme-controlled reaction at three different temperatures. Only the temperature was different for each experiment. The results are shown in the graph.



(a) Use your knowledge of enzymes to explain

(i) why the initial rate of reaction was highest at 55 °C;

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(2)

(ii) the shape of the curve for 55 °C after 20 minutes.

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(3)

(b) Explain why the curves for 27 °C and 37 °C level out at the same value.

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(2)
(Total 7 marks)

M1.(a) 1. (Phosphate) changes shape of TK / changes shape of enzyme / changes the active site;

It = phosphate

Accept 'alters' for changes

1. Reject that phosphate is an inhibitor

Accept adding energy / affecting charged / affects polar groups (on amino acids)

2. Active site forms / becomes the right shape / can bind to substrate / complementary to substrate / E-S complex can form;

2. Reject similar / same shape as substrate

2

(b) 1. Faulty TK has functional active site <u>without phosphate</u>;

Accept 'works without phosphate'

2. (So, faulty) TK functional all the time / TK not controlled (by phosphate);

2

(c) 1. Non-competitive inhibitor / binds to site other than active site;

Accept allosteric site

Do not accept 'changes shape' unqualified

2. Causes TK to be in non-functional form / active site not formed / wrong shape / E-S complex not formed;

3. So, (uncontrolled) cell division stopped / slowed / controlled;

2 max

[6]

M2. (a) Amino acid / amino acids ;

If anything else is given as well do not award mark.

1

(b) (i) 1. Affects one monomer / amino acid;

i.e. What is affected

2. Not found in all <u>active</u> <u>sites</u>;

i.e. Where it is found.

2. Must relate to active site. Enzyme is insufficient.

2

(ii) 1. **X**;

2. Enzyme in both pathways;

2 Award independently

2

(c) 1. Occupies / blocks / binds to active site;

i.e. What it does in terms of the active site.

2. Substrate will not fit / does not bind / no longer complementary to / enzyme-substrate complex not formed;

1. Ignore references to change in shape and shape of aspirin molecule.

Ignore reference to competitive inhibitor i.e. Consequence required

2

(d) 1. Prevents / reduces formation of thromboxane;

1. Must prevent/reduce production.

2. Blood clots do not form / less likely to form;

2. Accept converse from this point onwards

3. (Do not block) coronary arteries / vessels;

4. Heart muscle / wall gets oxygen;

4. Reference to heart must be qualified.

3 max

[10]

M3. (a) (i) Hydrolysis;

Accept phonetic spelling.

Ignore reaction.

1

(ii) (Alpha) glucose;

Accept α glucose.

Reject β glucose / beta glucose

1

(b) (i) Add Benedict's (reagent) and heat / warm;

Red/orange/yellow/green (colour);

Reject Add HCl

Accept brown, reject other colours

2

(ii) 2 products / 2 sugars produced;

*Look for idea of **two***

Accept named monosaccharides produced.

"More" insufficient for mark

Neutral if incorrect products named

Neutral "lactose is a polysaccharide"

Neutral "lactose is not a reducing sugar"

Neutral: Reference to surface area.

1

(c) 1. Galactose is a similar shape / structure to lactose/both complementary;

2. (Inhibitor / Galactose) fits into / enters / binds with active site (of enzyme);

3. Prevents/less substrate fitting into / binding with (active site) / fewer or no E-S complexes;

1. Q Reject: Same shape / structure

2. Accept blocks active site

Look for principles:

1 Shape

2 Binding to active site

3 Consequence

2 max

(d) Low / decreased water potential (in gut);

Water enters gut / lumen / leaves cells by osmosis;

Neutral ref to concentrations

Accept ψ for water potential

2

[9]

M4. (a) Active site;
(Complementary/specific) structure/shape;
(Only) fits/binds to gangliosides;

Forms enzyme-substrate complexes;

OR

Active site;
(Complementary/specific) structure/shape;
(Does not) fit/bind with other lipids;
Does not form enzyme-substrate complexes;

Note: 'active site has a specific shape' = 2 marks;
Reject: same shape

Second mark for either route can refer to the enzyme or the substrate

Accept: converse of second mark point and (different) structure/shape if referring to other lipids

3 max

(b) (i) No change/substrate remains high/horizontal line;

Curve should be labelled
*If curve **H** correctly labelled then assume other is curve **T***

Reject: obvious rise or fall/rise then plateau

1

(ii) Curve decreases rapidly at first then more slowly;

Curve should be labelled

*If curve **T** correctly labelled then assume other is curve **H***

Reject: falling at a slower rate initially

1

(c) (Enzymes are) proteins;
Digested/broken down/destroyed (by enzymes/acid);

OR

(Enzymes are) too large;
To cross cell membranes/be absorbed/enter the bloodstream;

Accept: denatured (by acid)

Neutral: digested by saliva

Reject: digested by amylase

Neutral: will not reach the bloodstream

2

[7]

M5. (a) (i) Curve rising and levelling out;

1

(ii) Substrate becomes limiting/falls/gets less;
Fewer collisions/complexes formed;

2

(b) To keep pH the same / optimum pH / so change in pH does not affect reaction;

1

(c) (i) For temperature up to 40 – 50 °C has no effect;
Over temperature (of 40 – 50 °C) reduces rate of reaction;

Note. Award one mark for general statement about the longer the incubation time, the slower the rate of reaction.

2

(ii) Bonds (holding tertiary structure) broken;
More enzyme denatured / tertiary structure destroyed;
Active sites lose shape/no longer fit;
Fewer enzyme-substrate complexes formed;

Note. Award marks if clearly in the context of more denaturation. Allow credit here for converse relating to exposure for 5 minutes.

max 3

(d) 1 Statement about two types, competitive and non-competitive;

Note. Award points 2 –5 only in context of competitive and non-competitive inhibition

<u>Competitive</u>
2 Similarity of shape of inhibitor and substrate;
3 Inhibitor can enter/bind with active site (of enzyme);

<u>Non-competitive</u>
4 Affect/bind to enzyme other than at active site;
5 Distorts shape of active site;

<u>Inhibitors</u>
6 Prevent entry of/binding of substrate to active site;
7 Therefore fewer/no enzyme-substrate complexes formed;

max 6

[15]

M6. (a) (i) substances/molecules have more (kinetic) energy/moving faster;
(reject vibrate)

increased collisions / enzyme substrate complexes formed;

2

(ii) causes denaturation/tertiary structure/shape change;
H^+/ionic bonds break;
(shape) of <u>active site</u> changed;
substrate no longer binds/not complementary to (active site);

3 max

(b) all substrate changed into product / reaction is complete;
same amount of product formed;
same initial substrate concentration;

2 max

[7]